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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/993,388	11/14/2001	Mark M. Wang	267/006	4938

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EXAMINER	
JOHNSTON, PHILLIP A	
ART UNIT	**PAPER NUMBER**
2881	

DATE MAILED: 11/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/993,388	WANG ET AL.	
	Examiner	Art Unit	
	Phillip A Johnston	2881	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 September 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *11-14-2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Detailed Action

1. This office action is responsive to an RCE date 9-29-2003.

2. The double Patenting Rejection as cited in the previous Office Action has been withdrawn as described in the Interview summary, Paper No. 9.

Claims Rejection – 35 U.S.C. 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,472,550 to Periasamy, in view of Becker, U.S. Patent No. 6,294,063 and in further view of Grier U.S. Patent No. 6,055,106.

Regarding Claims 1 and 11, Periasamy (550) discloses a process for preventing particulate contamination of a substrate surface, including the step of projecting a high intensity laser beam above a substrate surface to be protected, thereby to exert a photophoretic force upon particles upon which the laser beam impinges. Due to the

photophoretic force, the laser beam captures the particles so that the particles are physically confined within the laser beam. When the laser beam projects along a trajectory which does not contact the substrate surface particles entering the laser beam are not only captured but also transported by the laser beam, thereby protecting the substrate surface from contamination by those particles. Sere Column 1, line 62-67; and Column 2, line 1-7.

Periasamy (550) also discloses in FIG. 1, a laser beam 10 to be parallel to the surface of substrate 2, it is only necessary that laser beam 10 not impinge the surface of substrate 2. Laser beam 10 may be represented by a laser beam vector which points along the direction of propagation of laser beam 10 and which has a magnitude that is proportional to the intensity of laser beam 10. The laser beam vector may be represented by a component, which is parallel to the surface of substrate 2 and by a component which is perpendicular to the surface of substrate 2.

In one embodiment the laser beam vector along a portion of laser beam 10 , which opposes the surface of substrate 2 has a component perpendicular to surface of substrate 2 which points away from substrate 2. When there is a component of the laser beam vector which is perpendicular to the surface of substrate 2 pointing away from substrate 2, particles will be repelled from the surface of substrate 2 by laser beam 10 and may be prevented from reaching the surface of substrate 2 even if they are not captured in laser beam 10. Repulsion of particles by a laser beam assumes that the force from the laser beam upon the particle is a repulsive force. Usually the force due to a laser beam on a particle is a repulsive force.

FIG. 2 shows an embodiment in which laser beam 10 has such a positive vertical component. Laser beam 10 also impinges upon and is reflected by a surface of liquid nitrogen container particle getter 11. Liquid nitrogen container particle getter 11 includes a chamber for holding liquid nitrogen and fill tube 12a and drain tube 12b for filling and draining liquid nitrogen. Particles carried along laser beam 10 impinge upon a surface of liquid nitrogen container particle getter 11 which uses the principles of thermophoresis and, because that surface is cooled, stick to that surface (the second adhesive surface of Claims 1 and 11). Reflected portion 10a of laser beam 10 then passes through chamber window 6 and into beam stop 7.

FIG. 3 indicates that laser beam 10 may be spread into a fan shape in order to simultaneously cover a large portion of the surface of substrate 2. In FIG. 3, laser 3 generates laser beam 10, which traverses cylindrical lens 16 and is spread into fan beam 10b. Cylindrical lens 16 may either be inside or outside of chamber 1.

FIG. 4 shows another variation for protecting the surface of substrate 2 with a laser beam. In FIG. 4, laser 3 generates laser beam 10, which is scanned in a scanning motion along paths 10b by scanning of mirror 14. Mirror 14 is rotated by motor 13 which periodically rotates mirror 14 through a fixed angle in order to periodically scan or sweep reflecting beam 10b through that fixed angle. When the periodicity of reflecting beam 10b is high enough, the same effect for particle capture which is provided by the fanned out beam shown in FIG. 3 is obtained. Other scanning mechanisms, which provide a high scanning rate such as acousto-optic or piezoelectric scanning may be used to scan the laser beam in order to provide a high

enough scanning rate to capture all particles. An important point is that laser beam 10 is swept at a high enough frequency so that all particles whose trajectories intersect a path of the scanned beam experience a photophoretic force which captures those particles. See Column 3, line 53-67; and Column 4, line 1-44.

Periasamy (550) further discloses that the radiation force also provides a force on a particle, which tends to push the particle toward the central higher intensity region of laser beam 10 as indicated by FIG. 8. FIG. 8 shows along a cross section of a laser beam, the intensity distribution for that laser beam, a spherical semi-transparent particle in the laser beam path, along with the radiation forces upon that particle. The net effect of radiation forces on the particle is to drive particle along the propagation direction of the laser beam as indicated by F_{ax} in FIG. 8 and to drive that particle toward the higher intensity central portion of that laser beam, as indicated by F_{tr}. For a more detailed explanation of the radiation force see the article by Ashkin in Physical Review Letters, vol. 24, p. 156 (1970), which is herein incorporated by reference. See Column 7, line 2-19.

It is implied herein that Periasamy's (550) use of a radiation force that provides a force on a particle, which tends to push the particle toward the central higher intensity region of laser beam 10, is equivalent to the use of an optical gradient field to cause the selective separation of particles, as recited in claims 1 and 11.

It is also implied herein that the terms optophoretic and optophoresis, are equivalent to the terms photophoretic and photophoresis.

Periasamy (550) as applied above does not disclose the use of an optophoretic constant, as recited in Claims 1 and 11. However, Becker (063) discloses that Optical tweezers (which may consist of a focused laser beam with a light intensity gradient) may be also be used for trapping and manipulating packets (particles) of material. Optical manipulation requires that the refractive indices of the packets be different from that of their suspending medium, for instance, a partitioning medium as described herein. As light passes through one or more packets, it may induce fluctuating dipoles. Those dipoles may interact with electromagnetic field gradients, resulting in optical forces directed towards or away from the brighter region of the light. If their refractive indices are higher than that of the partitioning medium, packets may be trapped in a bright region, and when the laser light moves with respect to the partitioning medium, packets may follow the light beam, allowing for optical manipulation forces.

Conversely, if the packets have refractive indices smaller than their partitioning medium, they will experience forces directing them away from bright regions.

Therefore, if packets have different refractive indexes from that of the partitioning medium (e.g., water packets in air or oil), optical tweezers may exert forces on them. Therefore, to manipulate and interact packets, a microscope or other optical system incorporating one or more laser tweezers may be used. A chamber containing a partitioning medium in accordance with the present disclosure may be placed into such an optical system. Following the introduction of packets of material into the chamber, laser tweezers may be used to trap packets. By moving the focal point of

the optical tweezers with respect to the partitioning medium (e.g., moving a stage holding the thin chamber containing the partitioning medium whilst fixing the position of laser tweezers and/or by focusing the laser beam to different depths in the partitioning medium), packets may be manipulated as described herein. Through the use of apparatus such as a computer-controllable, multi-axis translation stage, the movement of the optical tweezers with respect to the suspending medium may be programmed or automatically controlled. Thus the optical tweezer may be moved, with respect to the medium, along any arbitrarily chosen or predetermined paths. By doing so, packets under the influences of the optical tweezers may be manipulated along any arbitrarily chosen or predetermined paths. See Column 25, line 36-67; and Column 26, line 1-10.

Therefore it would have been obvious to one of ordinary skill in the art that the particle sorting system of Periasamy (550) can be modified to use the adhesion preventive coating of Becker (063)

Regarding Claims 3 and 15, Becker (063) also discloses in FIG. 4 a three dimensional view of one embodiment of a fluidic device 10 according to the present disclosure. Fluidic device 10 includes reaction surface 12, an inlet port 14, an outlet port 16, driving electrodes 18, impedance sensing electrodes 19, connectors 20, and wall 22.

Reaction surface 12 provides an interaction site for packets. In one embodiment, reaction surface 12 may be completely or partially covered with a partitioning medium (not shown in FIG. 4) or other substance. In one embodiment, reaction surface 12 may be coated. In particular, for manipulation of aqueous packets in a hydrophobic

partitioning medium, reaction surface 12 may include a hydrophobic coating, or layer, having a hydrophobicity similar to or greater than the hydrophobicity of the partitioning medium. Such a coating may prevent an aqueous packet from sticking, from spreading, or from becoming unstable upon contact with reaction surface 12. Additionally, a coating may modify association and/or interaction forces between packets and reaction surfaces to facilitate manipulation of packets by appropriate manipulation forces. Further, a coating may be used to reduce contamination of reaction surfaces by reagents in packets. Still further, a coating may facilitate the deliberate adhesion, wetting, or sensing of packets at or on reaction surfaces. If a dielectric layer coating is applied, the layer should be made sufficiently thin to allow AC electric field penetration through the dielectric layer. In one embodiment, the thickness of the layer may be between about 2 nm and about 1 micron. In one embodiment, a hydrophobic coating may be Teflon that may be applied by means known in the art such as sputtering or spin-coating. It is to be understood that any other suitable coating that modifies an interaction between packets and the reaction surface may be used. See Column 11, line 57-67; and Column 12, line 1-22.

Therefore it would have been obvious to one of ordinary skill in the art that the particle sorting system of Periasamy (550) can be modified to use the adhesion preventive coating of Becker (063) to deliberately prevent a coating from sticking to a reaction surface.

Periasamy (550) in view of Becker, as applied above does not disclose the use of a moving optical gradient field; however, Grier (106) discloses a prior art optical

tweezer system 10 of FIG. 1,wherein the optical gradient forces arise from use of a single beam of light 12 to controllably manipulate a small dielectric particle 14 dispersed in a
medium 16 whose index of refraction, n_m, is smaller than that of the particle 14. The nature of the optical gradient forces is well known, and also it is well understood that the principle has been generalized to allow manipulation of reflecting, absorbing and low dielectric constant particles as well. Any of these techniques can be implemented in the context of the invention described hereinafter and will be encompassed by use of the terminology optical tweezer, optical trap and optical gradient force trap hereinafter.

In the optical tweezer system 10 either static or time dependent diffractive optical elements 40 can be used. For a dynamic (moving optical gradient), or time dependent version, one can create time changing arrays of the optical traps 50 which can be part of a system utilizing such a feature. In addition, these dynamic optical elements 40 can be used to actively move particles and matrix media relative to one another, as recited in Claim 1. For example, the diffractive optical element 40 can be a liquid crystal phase array undergoing changes imprinted with computer-generated holographic patterns.

In another embodiment illustrated in FIG. 5, a system can be constructed to carry out continuous translation of the optical tweezer trap 50. A gimbal mounted mirror 60 is placed with its center of rotation at point A. The light beam 12 is incident on the surface of the mirror 60 and has its axis passing through point A and will be projected

to the back aperture 24. Tilting of the mirror 60 causes a change of the angle of incidence of the light beam 12 relative to the mirror 60, and this feature can be used to translate the resulting optical trap 50. A second telescope 62 is formed from lenses L3 and L4 which creates a point A' which is conjugate to point A. The diffractive optical element 40 placed at point A' now creates a pattern of diffracted beams 64, each of which passes through point A to form one of the tweezer traps 50 in an array of the optical tweezers system 10. See Column 3, line 20-32; and Column 5, line 12-36.

Therefore it would have been obvious to one of ordinary skill in the art that optical sorting apparatus and method of Periasamy (550) in view of Becker (063) can be modified to use the moving optical gradient field in accordance with Grier (106), to improve the translational capability of the system.

It is implied herein that use of a particles dielectric properties, as well as index of refraction to manipulate the particle in accordance with Periasamy (550) in view of Becker (063) and in further view of Grier (106), is equivalent to the use of an optophoretic constant to selectively separate particles, as recited in Claims 1 and 11.

Conclusion

5. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 7:30 am to 4:00 pm. If attempts to

reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 872-9318 for regular response activity, and (703) 872-9319 for after-final responses. In addition the customer service fax number is (703) 872- 9317.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ

October 27, 2003

SUPERVISORY PATENT EXAMINER